PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION CONCERNING
AMENDMENTS OF THE CLAIMS

(PCT Rule 62 and
Administrative Instructions, Section 417)

To:

Assistant Commissioner for Patents
United States Patent and Trademark
Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as International Preliminary Examining Authority

Date of mailing (day/month/year)	
18 February 2000 (18.02.00)	
International application No.	International filing date (day/month/year)
PCT/IL99/00234	04 May 1999 (04.05.99)
Applicant	
LIBIT SIGNAL PROCESSING LTD. et al	

The International Bureau hereby informs the International Preliminary Examining Authority that no amendments under Article 19 have been received by the International Bureau (Administrative Instructions, Section 417).

The International Bureau of WIPO
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Authorized officer

Jean-Marc Vivet

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PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

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NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents
United States Patent and Trademark Office
Box PCT
Washington, D.C.20231
ÉTATS-UNIS D'AMÉRIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 18 February 2000 (18.02.00)	
International application No. PCT/IL99/00234	**Applicant's or agent's file reference** P-1649-PC
International filing date (day/month/year) 04 May 1999 (04.05.99)	**Priority date** (day/month/year) 04 May 1998 (04.05.98)
Applicant MELAMED, Oded et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

03 December 1999 (03.12.99)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO **34, chemin des Colombettes** **1211 Geneva 20, Switzerland**	Authorized officer Jean-Marc Vivet
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09/674550

PATENT COOPERATION TREATY

RECD 15 JAN 2001

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

15

Applicant's or agent's file reference P-1649-PC	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/IL99/00234	International filing date *(day/month/year)* 04 MAY 1999	Priority date *(day/month/year)* 04 MAY 1998
International Patent Classification (IPC) or national classification and IPC IPC(7): H03D 1/24; H04L 27/10 and US Cl.: 375/277, 321		
Applicant LIBIT SIGNAL PROCESSING LTD.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 4 sheets.

   ☐ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority. (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 0 sheets.

3. This report contains indications relating to the following items:

   I ☒ Basis of the report

   II ☐ Priority

   III ☐ Non-establishment of report with regard to novelty, inventive step or industrial applicability

   IV ☐ Lack of unity of invention

   V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

   VI ☐ Certain documents cited

   VII ☐ Certain defects in the international application

   VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
03 DECEMBER 1999	06 NOVEMBER 2000
Name and mailing address of the IPEA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer KEVIN BURD Telephone No. (703) 308-7034

Form PCT/IPEA/409 (cover sheet) (July 1998)★

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/IL99/00234

I. Basis of the report

1. With regard to the **elements** of the international application:*

[X] the international application as originally filed

[X] the description:
pages 1-8 , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____

[X] the claims:
pages 9-10 , as originally filed
pages NONE , as amended (together with any statement) under Article 19
pages NONE , filed with the demand
pages NONE , filed with the letter of _____

[X] the drawings:
pages 1-3 , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____

[X] the sequence listing part of the description:
pages NONE , as originally filed
pages NONE , filed with the demand
pages NONE , filed with the letter of _____

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

[ ] the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

[ ] the language of publication of the international application (under Rule 48.3(b)).

[ ] the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

[ ] contained in the international application in printed form.

[ ] filed together with the international application in computer readable form.

[ ] furnished subsequently to this Authority in written form.

[ ] furnished subsequently to this Authority in computer readable form.

[ ] The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

[ ] The statement that the information recorded in computer readable form is identical to the writen sequence listing has been furnished.

4. [X] The amendments have resulted in the cancellation of:

[X] the description, pages NONE

[X] the claims, Nos. NONE

[X] the drawings, sheets/~~fig~~ NONE

5. [ ] This report has been drawn as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*

***Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/IL99/00234

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. statement

Novelty (N)	Claims	1-5, 7 and 10	YES
	Claims	6, 8, 9	NO
Inventive Step (IS)	Claims	5 and 10	YES
	Claims	1-4 and 6-9	NO
Industrial Applicability (IA)	Claims	1-10	YES
	Claims	NONE	NO

2. citations and explanations (Rule 70.7)

Claims 1-4 and 7 lack an inventive step under PCT Article 33(3) as being obvious over Gysel (US 5,430,798).

Regarding claim 1, Gysel discloses a method and apparatus for receiving vestigial sideband (VSB) signals comprising: filtering a baseband VSB signal having a positive frequency signal edge to provide a portion of said positive frequency signal edge (figure 4 item 34 and column 5 lines 62-67) and a timing retrievable signal is provided to compensate for delays present in the signals (column 1 lines 31-36). Gysel does not disclose narrow band pass filtering the incoming signal. However the necessary components of the signal are recovered to allow the delay components of the signals to be compensated.

Regarding claims 2 and 7, Gysel does not disclose the act of averaging the time retrievable signal. However it would have been obvious to collect numerous occurrences of this signal and average them over time. This additional step of averaging the signals would allow for the compensation of an unusually long of short delay which would occur rarely but happened to occur over the averaging time period. The extra long or short delay would not cause a large error because of the step of averaging the signal.

Regarding claims 3 and 4, Gysel also discloses the center frequency is 45.75 MHz. (column 5 line 66) and the frequency band is 41.25 MHz to 50.25 MHz (column 5 lines 65-66).

Claims 6, 8 and 9 lack novelty under PCT Article 33(2) as being anticipated by Gysel (US 5,430,798).

Regarding claim 6, Gysel discloses a method and apparatus for receiving vestigial sideband (VSB) signals comprising: filtering a baseband VSB signal having a positive frequency signal edge to provide a portion of said positive frequency signal edge (figure (Continued on Supplemental Sheet.)

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Continuation of: Boxes I - VIII

V. 2. REASONED STATEMENTS - CITATIONS AND EXPLANATIONS (Continued):
4 item 34 and column 5 lines 62-67) and a timing retrievable signal is provided to compensate for delays present in the signals (column 1 lines 31-36).

Regarding claims 8 and 9, Gysel also discloses the center frequency is 45.75 MHz. (column 5 line 66) and the frequency band is 41.25 MHz to 50.25 MHz (column 5 lines 65-66).

Claims 5 and 10 meet the criteria set out in PCT Article 33(2)-(4), because the prior art does not teach or fairly suggest providing the imaginary component of the complex signal as the timing retrievable signal.

---------- NEW CITATIONS ----------
US 5,430,798 A (GYSEL) 04 JULY 1995, see column 1 lines 20-52, column 5 lines 52-67 and figure 4

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WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

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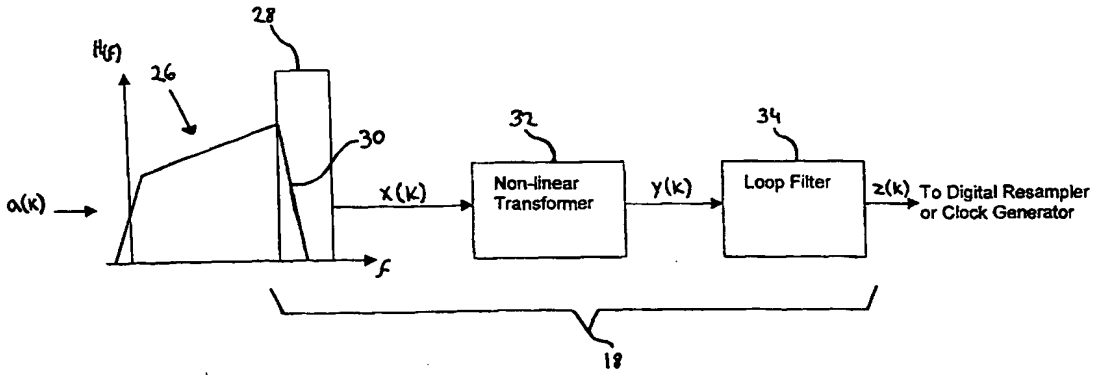
(54) Title: METHODS AND APPARATUS FOR TIMING RECOVERY OF VESTIGIAL SIDEBAND (VSB) MODULATED SIGNALS



(57) Abstract

Apparatus for timing recovery of vestigial sideband (VSB) modulated signals including a narrow band pass filter (28) adapted to receive a baseband VSB signal (26) having a positive-frequency signal edge (30) and providing a portion of the positive-frequency signal edge (30). A non-linear transformer (32) is adapted to receive the signal portion and provide a timing-retrievable signal to a loop filter (34) which is adapted to receive and average the timing-retrievable signal to provide a timing corrected signal.

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METHODS AND APPARATUS FOR TIMING RECOVERY OF VESTIGIAL SIDEBAND (VSB) MODULATED SIGNALS

FIELD OF THE INVENTION

The present invention relates to digital signal processing systems in general, and more particularly to methods and apparatus for timing recovery of vestigial sideband (VSB) modulated signals.

BACKGROUND OF THE INVENTION

The recovery of data from a VSB signal at a receiver requires the implementation of timing recovery for symbol synchronization by which the receiver clock (timebase) is synchronized to the transmitter clock. This permits the received signal to be sampled at the optimum point in time, thus reducing the chance of a slicing error associated with decision-directed processing of received symbol values. Prior-art VSB receivers utilize a known synchronization (sync) pattern to extract timing information from the VSB signal. For example, the Digital Television Standard Document A/55 published by the American Television Standards Committee (ATSC) defines a 4 symbol sync pattern for every 832 symbols transmitted in a VSB signal. Receivers that utilize such sync patterns, such as is described in U.S. Patent No. 5,260,793, typically suffer from a relatively long convergence time as well as convergence to a poor solution where strong and close (less than pattern length) intersymbol interference is present.

The disclosures of all patents, patent applications, and other publications

mentioned in this specification and of the patents, patent applications, and other publications cited therein are hereby incorporated by reference.

SUMMARY OF THE INVENTION

The present invention seeks to provide methods and apparatus for timing recovery of digital vestigial sideband (VSB) signals that overcomes the disadvantages of the prior art described above. A "blind" approach is employed where a baseband VSB signal is filtered by a band-edge filter. The filter output is then transformed using a non-linear transformation and then filtered using a linear filter. The output is then used as a timing correction signal to a digital resampler and/or to an external clock source. In this manner the energy contained in the sampled received signal is maximized. This approach is more responsive to signal reflections in the channel and has a faster acquisition time than do prior art receivers.

There is thus provided in accordance with a preferred embodiment of the present invention apparatus for timing recovery of vestigial sideband (VSB) modulated signals including a narrow band pass filter adapted to receive a baseband VSB signal having a positive-frequency signal edge and provide a portion of the positive-frequency signal edge, and a non-linear transformer adapted to receive the signal portion and provide a timing-retrievable signal adapted for retrieval of timing information therefrom.

Further in accordance with a preferred embodiment of the present invention the apparatus further includes a loop filter adapted to receive the timing-retrievable signal and average the timing-retrievable signal to provide a timing correction signal.

Still further in accordance with a preferred embodiment of the present invention the pass band of the band pass filter generally encompasses the

positive-frequency signal edge, and the center frequency of the positive-frequency signal edge is included in the signal portion.

Additionally in accordance with a preferred embodiment of the present invention the signal portion includes a nonzero band of frequencies of the positive-frequency signal edge frequency.

Moreover in accordance with a preferred embodiment of the present invention the non-linear transformer is adapted to square the signal portion thereby providing a complex signal having a real and an imaginary component and provide the imaginary component as the timing-retrievable signal.

There is also provided in accordance with a preferred embodiment of the present invention a method for timing recovery of vestigial sideband (VSB) modulated signals, the method including filtering a baseband VSB signal having a positive-frequency signal edge to provide a portion of the positive-frequency signal edge, and non-linearly transforming the signal portion to provide a timing-retrievable signal adapted for retrieval of timing information therefrom.

Further in accordance with a preferred embodiment of the present invention the method further includes averaging the timing-retrievable signal to provide a timing correction signal.

Still further in accordance with a preferred embodiment of the present invention the filtering step provides the center frequency of the positive-frequency signal edge included in the signal portion

Additionally in accordance with a preferred embodiment of the present invention the filtering step provides a nonzero band of frequencies of the positive-frequency signal edge frequency included in the signal portion.

Moreover in accordance with a preferred embodiment of the present invention the transforming step includes squaring the signal portion, thereby providing a complex signal having a real and an imaginary component, and providing the imaginary component as the timing-retrievable signal.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood and appreciated more fully from the following detailed description taken in conjunction with the appended drawings in which:

Fig. 1 is a simplified graphical illustration of the spectrum of a baseband VSB signal useful in understanding the present invention;

Fig. 2 is a simplified block diagram of a VSB receiver constructed and operative in accordance with a preferred embodiment of the present invention; and

Fig. 3 is a simplified block diagram of the VSB receiver timing block of Fig. 2.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Reference is now made to Fig. 1 which is a simplified graphical illustration of the spectrum of a baseband VSB signal useful in understanding the present invention as described hereinbelow. A VSB modulated signal is defined herein as a signal of the form $v(t) = \mathrm{Re}\{\sum_n a_n p(t-nT)e^{j2\pi f_c t}\}$, where a_n are the information symbols, $p(t)$ is the modulation pulse shape, f_c is the carrier frequency, T is the symbol period, and $Re\{\}$ represents the real component of a complex number. A baseband VSB signal is defined herein as a complex signal of the form $b(t) = \sum_n a_n p(t-nT)$. A spectrum S of a

baseband VSB signal is shown in Fig. 1, having a positive frequency signal edge 2 and a negative frequency signal edge 4. A negative frequency edge center 6 is defined herein as the signal at a frequency of 0. A positive frequency edge center 8 is defined as the signal at frequency $\frac{1}{2T}$. Note that the negative frequency edge center 6 and the positive frequency edge center 8 are usually the 3DB bandwidth points of the VSB signal.

Reference is now made to Fig. 2 which is a simplified block diagram of a VSB receiver constructed and operative in accordance with a preferred embodiment of the present invention. A VSB modulated signal 10 embodying transmitted data is shown being received by a tuner 12 and down-converted to a signal 12' of an intermediate frequency (IF), preferably a standard IF frequency such as 44 MHz, prior to channel decoding. The down-converted signal 12' is then sampled at an analog-to-digital (A/D) converter 14 to an A/D converted signal 14'. The VSB pilot tone of signal 14' is then detected using a frequency-and-phase-locked loop (FPLL) 16 which locks the carrier frequency and phase and produces an I/Q signal 16' typically comprised of both in-phase (I) and quadrature-phase (Q) signal components. FPLL 16 preferably shifts signal 16' in frequency such that the spectrum of signal 16' appears as spectrum S in Fig. 1.

In one mode of operation FPLL 16 then feeds the I/Q signal 16' to a digital resampler 20 which preferably comprises a digital numerically controlled oscillator (NCO). A timing recovery block 18 then processes a signal 20' output from digital resampler 20 to derive a timing correction signal 18' which may then be fed back to digital resampler 20. Digital resampler 20 may process the I/Q signal 16' received from FPLL 16 using the timing correction signal 18' to derive T-spaced or fractionally sampled signals which are synchronized with the transmitted clock rate embodied in

VSB modulated signal 10. The resampled signal is then fed to a VSB detector 24 which derives the data from the signal.

In an additional or alternative mode of operation FPLL 16 feeds the I/Q signal 16' directly to VSB detector 24, bypassing digital resampler 20. The timing correction signal 18' is then fed to an external clock generator 22 which may be used to drive the A/D converter 14 in synchronicity with the transmitted clock rate.

Additional reference is now made to Fig. 3 which is a simplified block diagram showing timing recovery block 18 of Fig. 2 in greater detail. Signal 20' (Fig. 2), shown in Fig. 3 as input signal $a(k)$ and generally designated 26, is a complex signal having a real component, being the in-phase (I) component described hereinabove with reference to Fig. 2, and an imaginary component, being the quadrature-phase (Q) component. Signal 26 is filtered by a narrow band-pass filter 28 centered at a positive-frequency signal edge 30 of signal 26. Preferably, the pass band of filter 28 generally encompasses positive-frequency signal edge 30, and filter 28 provides a portion of positive-frequency signal edge 30. The signal portion preferably includes the center frequency of edge 30, and most preferably a nonzero band of frequencies of positive-frequency signal edge 30. The output of filter 28, shown in Fig. 3 as signal $x(k)$, is then passed to a non-linear transformer 32 which is preferably a square function that raises to the power of two. The output of transformer 32, when averaged over time, is proportional to the symbol timing offset of the signal 16', and may therefore be used to derive a timing correction signal that may be fed to a digital resampler or an external clock source such as a voltage controlled oscillator (VCXO). To derive the timing correction signal the imaginary component output of transformer 32 expressed by the equation $y(k) = Im\{x(k)^2\}$) is fed to a loop filter 34 which is defined by the following

equations:

$$z(k) = d \cdot y(k) + g(k)$$

$$g(k) = g(k-1) + c \cdot y(k-1)$$

where k is the time index, $x(k)$ is the input to transformer 32, $y(k)$ is the input to the loop filter 34, $z(k)$ is the output of loop filter 34, and c and d are constants. Constants c and d determine the bandwidth and convergence time of the timing loop as is well known in the art for PLLs. Performance may also be affected by the choice of the band pass filter 28, where the narrower the filter, the less noisy the steady state output but with slower convergence.

It is appreciated that the averaging over time of the output of transformer 32 may be accomplished by other known substitutes for loop filter 34 described hereinabove.

As was explained above, digital resampler 20 (Fig. 2) preferably includes a digital numerically controlled oscillator (NCO) that generates the nominal timing instances of the signal and modifies them according to the correction signal $z(k)$. If we denote the timing instances by $t(n)$, then:

$$t(n+1) = t(n) + Tnom + z(k)$$

where $Tnom$ is the nominal time (in samples of the input signal) between output samples. For example, if the input is sampled at 3.4 samples per symbols, and the desired resampler output is 2 samples per symbol, then $Tnom = 3.4/2 = 1.7$. When used in conjunction with an analog VCXO, the VCXO is assumed to be nominally tuned to the nominal sampling frequency of the signal. The VCXO then changes its frequency relative to the nominal frequency by an amount relative to the correction signal input to the VCXO. If we denote the VCXO output frequency by f(t), then:

$$f(t) = Fnom + u \cdot z(k)$$

where *Fnom* is the nominal frequency and u is a constant.

While the present invention has been described with reference to a few specific embodiments, the description is intended to be illustrative of the invention as a whole and is not to be construed as limiting the invention to the embodiments shown. It is appreciated that various modifications may occur to those skilled in the art that, while not specifically shown herein, are nevertheless within the true spirit and scope of the invention.

CLAIMS

What is claimed is:

1. Apparatus for timing recovery of vestigial sideband (VSB) modulated signals comprising:

a narrow band pass filter adapted to receive a baseband VSB signal having a positive-frequency signal edge and provide a portion of the positive-frequency signal edge; and

a non-linear transformer adapted to receive said signal portion and provide a timing-retrievable signal adapted for retrieval of timing information therefrom.

2. Apparatus according to claim 1 and further comprising a loop filter adapted to receive said timing-retrievable signal and average said timing-retrievable signal to provide a timing correction signal.

3. Apparatus according to claim 1 wherein the pass band of said band pass filter generally encompasses said positive-frequency signal edge, and wherein the center frequency of said positive-frequency signal edge is included in said signal portion.

4. Apparatus according to claim 3 wherein said signal portion includes a nonzero band of frequencies of said positive-frequency signal edge frequency.

5. Apparatus according to claim 1 wherein said non-linear transformer is adapted to square said signal portion thereby providing a complex signal having a real and an imaginary component and provide said imaginary component as said

timing-retrievable signal.

6. A method for timing recovery of vestigial sideband (VSB) modulated signals, the method comprising:

filtering a baseband VSB signal having a positive-frequency signal edge to provide a portion of said positive-frequency signal edge; and

non-linearly transforming said signal portion to provide a timing-retrievable signal adapted for retrieval of timing information therefrom.

7. A method according to claim 6 and further comprising averaging said timing-retrievable signal to provide a timing correction signal.

8. A method according to claim 6 wherein said filtering step provides the center frequency of said positive-frequency signal edge included in said signal portion

9. A method according to claim 8 wherein said filtering step provides a nonzero band of frequencies of said positive-frequency signal edge frequency included in said signal portion.

10. A method according to claim 6 wherein said transforming step comprises squaring said signal portion, thereby providing a complex signal having a real and an imaginary component, and providing said imaginary component as said timing-retrievable signal.

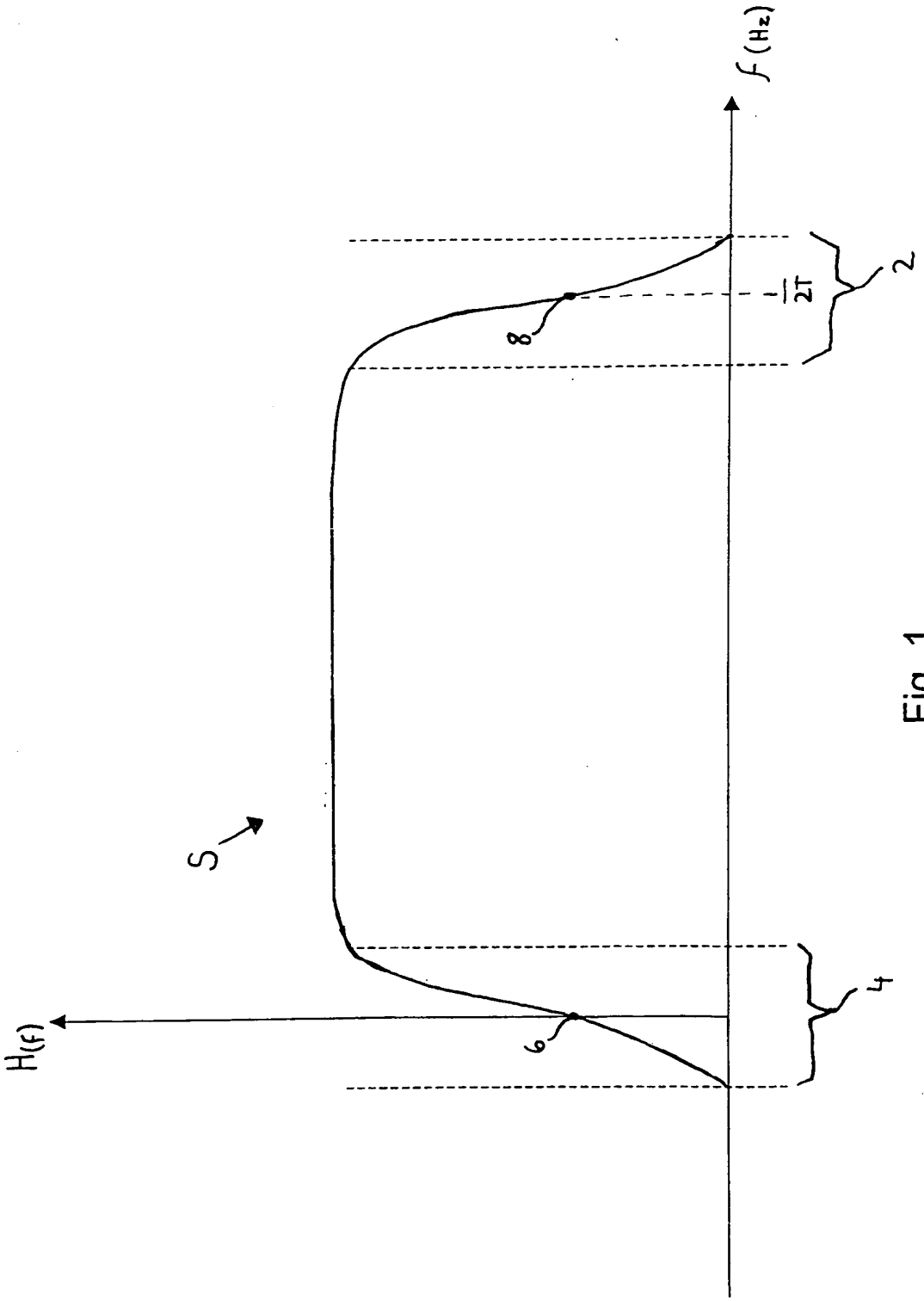

Fig. 1

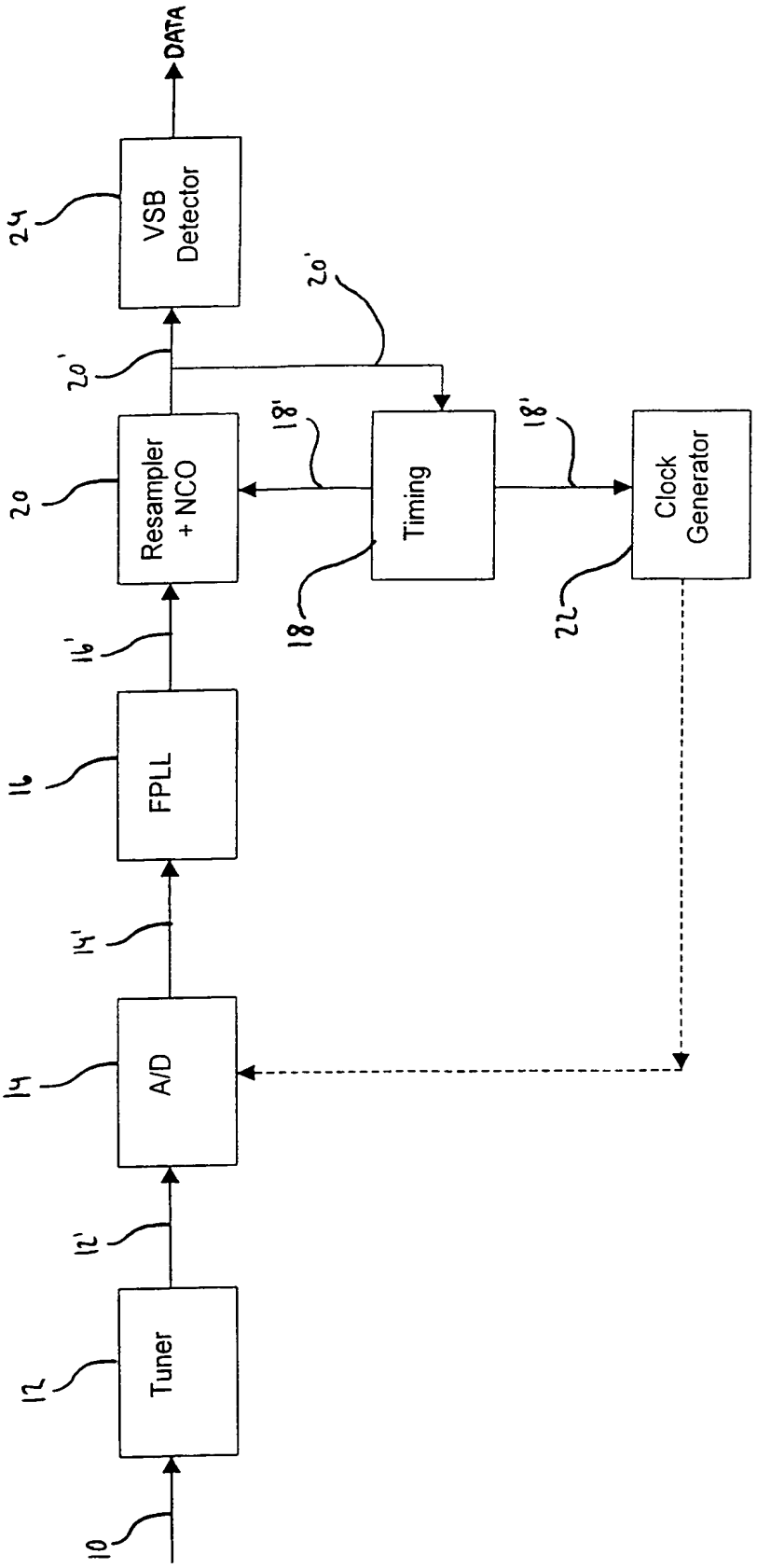
DATA
VSB Detector
24
20'
20'
Resampler + NCO
20
18'
Timing
18'
Clock Generator
18
22
16'
FPLL
16
14'
A/D
14
12'
Tuner
12
10

Fig. 2

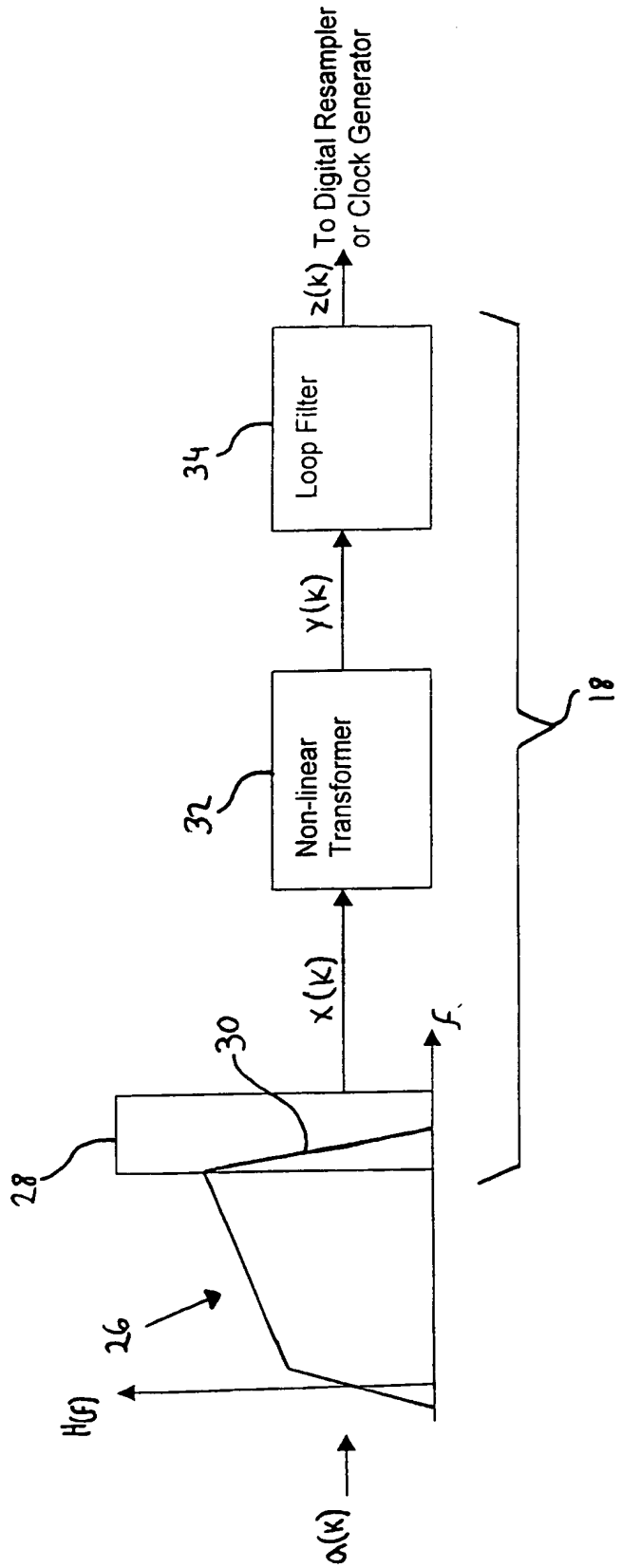
To Digital Resampler or Clock Generator
z(k)
Loop Filter
34
y(k)
Non-linear Transformer
32
x(k)
30
28
26
H(f)
a(k)
18

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL99/00234

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :H03D 1/24; H04L 27/10

US CL : 375/277, 321

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 375/277, 321, 355

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,712,873 A (SHIUE et al) 27 January 1998, col. 3, lines 37-44.	1-10
A	US 5,706,057 A (STROLLE et al) 06 January 1998, col. 1, lines 13-23.	1-10
A	US 5,694,419 A (LAWRENCE et al) 02 December 1997, col. 17, lines 14-19, abstract.	1-10
Y	US 4,312,075 A (MURANO et al) 19 January 1982, col. 7,8 and 10, lines 49-68, 1-5 and 10-16.	1,3,5,6,8 and 10
Y	US 5,717,715 A (CLAYDON et al) 10 Feburary 1998, col. 1 lines 49-55.	1-10

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
28 JULY 1999	30 AUG 1999
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer KEVIN M. BURD Telephone No. (703) 308-7034

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